WHAT IS CLAIMED IS

1. A multilayer interconnection structure, comprising:

a first interconnection layer including a copper interconnection pattern;

an interlayer insulation film formed on said first interconnection layer;

a second interconnection layer formed on said interlayer insulation film;

a via-hole formed in said interlayer insulation film so as to expose said copper interconnection pattern; and

a tungsten plug formed in said via-hole so as to connect said first interconnection layer and said second interconnection layer electrically,

said via-hole having a depth/diameter ratio of 1.25 or more,

wherein there is formed a conductive nitride film between an outer wall of said tungsten plug and an inner wall of said via-hole such that said conductive nitride film is defined by an inner wall contacting with said outer wall of said tungsten plug and an outer wall contacting with said inner wall of said via-hole.

2. The multilayer interconnection structure as claimed in claim 1, wherein said conductive nitride film comprises a TaN film.

3. The multilayer interconnection structure as claimed in claim 1, wherein said conductive nitride film is formed of a first nitride film and a second nitride film stacked inside said first nitride film.

4. The multilayer interconnection structure as claimed in claim 3, wherein said first nitride film is formed of a TaN film and said second nitride film is formed of a TiN film.

5. The multilayer interconnection structure as claimed in claim 1, wherein said nitride film has a composition showing corrosion resistance to a fluoride gaseous source of tungsten, which is used for forming said tungsten plug.

6. The multilayer interconnection structure as claimed in claim 1, wherein said second interconnection layer contains an aluminum interconnection pattern.

7. A method of forming a multilayer interconnection structure, comprising the steps of:

forming an interlayer insulation film on a first interconnection layer including a copper

interconnection pattern;

forming a via-hole in said interlayer insulation film so as to expose said copper interconnection pattern;

introducing a substrate carrying thereon said first interconnection layer and said interlayer insulation film into a reactive sputtering apparatus and forming a nitride film on said interlayer insulation film by a reactive sputtering process, such that said nitride film covers an inner wall surface of said via-hole;

forming a tungsten plug, after said step of forming said nitride film, on said interlayer insulation film such that said tungsten plug fills said via-hole; and

forming a second interconnection layer, after said step of forming said tungsten plug, on said interlayer insulation film,

wherein there are provided, after said step of forming said nitride film but before said step of forming said tungsten plug, the steps of:

isolating said substrate from a sputtering target provided in said reactive sputtering apparatus; and

cleaning a surface of said sputtering target, after said step of forming said nitride film, in said reactive sputtering apparatus in a state in which said substrate is isolated from said sputtering target.

8. The method as claimed in claim 7, wherein said cleaning step is conducted such that a nitride film on said sputtering target is removed and the surface of a metal constituting said sputtering target

is exposed

9. The method as claimed in claim 89, wherein said cleaning step is finished, after said surface of said metal is exposed at said sputter target surface, by conducting a reactive sputtering process of a nitride film.

10. The method as claimed in claim 7, wherein said step of isolating said substrate is conducted by taking out said substrate out of said reactive sputtering apparatus.

11. The method as claimed in claim 10, wherein said sputtering apparatus forms a single-wafer processing apparatus together with a vacuum transportation chamber coupled to said sputtering apparatus and further with another processing chamber coupled to said vacuum transportation chamber, and wherein said step of taking out said substrate out of said sputtering apparatus comprises a step of transporting said substrate from said another processing chamber via said vacuum transportation chamber.

12. The method as claimed in claim 11, wherein said another processing chamber is a CVD chamber used for forming a tungsten film.

13. The method as claimed in claim 7, wherein said step of isolating said substrate comprises a step of introducing a shutter inside said reactive sputtering apparatus between said substrate and said sputtering target.

14. The method as claimed in claim 7, wherein said step of introducing said nitride film comprises a step, after introducing said substrate into said reactive sputtering apparatus but before exciting plasma, of introducing a nitrogen gas to a surface of said substrate.

15. The method as claimed in claim 7, wherein said step of forming said tungsten plug is conducted by a CVD process using a fluoride gaseous source of tungsten so as to fill said via-hole by a tungsten film via said nitride film, and wherein said step of filling said via-hole by said tungsten film is conducted while supplying a hydrogen gas to a surface of said substrate.

16. The method as claimed in claim 7, wherein said step of forming said tungsten plug comprises the steps of: forming a passivation film of tungsten on said nitride film covering said inner wall surface of said via hole, by supplying a gaseous source of tungsten and a reactive gas decomposing said fluoride gaseous source to a surface of said via-hole alternately with an intervening purging process; and depositing a tungsten film on said passivation film by a CVD process, wherein at least said step of forming said passivation film is conducted while supplying a hydrogen gas to a surface of said substrate.

17. The method as claimed in claim 7, wherein said step of forming said tungsten plug comprises the step of processing a surface of said via hole, before deposition of said tungsten film, by plasma of a gas containing hydrogen.

18. A semiconductor device, comprising:

a substrate; and

a multilayer interconnection structure formed on said substrate,

said multilayer interconnection structure comprising:

a first interconnection layer including a copper interconnection pattern;

an interlayer insulation film formed on said first interconnection layer;

a second interconnection layer formed on said interlayer insulation film;

a via-hole formed in said interlayer insulation film so as to expose said copper interconnection pattern; and

a tungsten plug formed in said via-hole so as to connect said first interconnection layer and said second interconnection layer electrically,

said via-hole having a depth/diameter ratio of 1.25 or more,

wherein there is formed a conductive nitride film between an outer wall of said tungsten plug and an inner wall of said via-hole such that said conductive nitride film is defined by an inner wall contacting with said outer wall of said tungsten plug and an outer wall contacting with said inner wall of said via-hole.